MICRO-SUPPORT CUSHIONING SYSTEM

Related Application

[0001] This application claims priority from U.S. Provisional Application No. 60/400,336 filed July 31, 2002, incorporated herein by reference.

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Technical Field

[0003] The present invention pertains to cushioning methods and devices for cushioning the human body or parts thereof, and more specifically, pertains to fine-grained "micro-support" cushioning methods that comply or respond to specific regions of the body.

Background of the Invention

[0004] Known devices do not and cannot actually form to the human body and give continuous support (in the spatial rather than temporal sense). For example, when a person lies on a mattress the shoulders and hips depress the mattress at such an angle and to such a degree that the mattress cannot respond with localized and/or adequate support for the lower back. The result is not only a sore back but also pressure points that interfere with proper circulation.

[0005] Manufacturers of footwear, furniture, and mattresses are concerned with comfort. Industry leaders in those fields have, to varying degrees, relied on air, liquid, or thermoplastic elastomers to provide comfort or in some cases, improved athletic performance. In addition, footwear manufacturers normally include some

type of inner sole to provide additional comfort and support. In addition after-market companies have also produced similar inner soles.

[0006] Generally the above-mentioned manufacturers have attempted to realize the benefits of comfort or improved performance with a single plastic composite because a single composite generally reduces manufacturing costs. Typically, of an assembly of multiple parts was viewed as too costly and too time consuming. Recently, a new injection molding process of "overshooting," in which a mold is made of one plastic and then a second plastic is "overshot" onto the first plastic, has been developed and might permit the production of multiple layers although that process can still be too costly.

[0007] Alternate solutions have been pioneered that incorporate mechanical attributes with the deflection properties of plastic. For example, U.S. Patents 5,461,800, 5,279,051, and 6,199,303 embody the idea of plastic springs to provide shock absorption and stability with the objective of reducing stress on the leg muscles and joints. While these approaches are noteworthy in that they mimic certain traditional metal springs and maintain the advantage of low injection molding costs, they fall short of a demonstrable agility to respond to the forces of walking/running in a precise and opposing reaction to the energies and forces delivered by the back heel towards the toes that generate the forward thrust necessary for a second step. In practice these devices typically function as cushioned platforms because they do not have the necessary flexibility to mimic the human condition of walking or running as one might envision for maximum creature comfort (e.g., running barefoot on the beach).

Summary of the Invention

[0008] An analysis of the above described problem revealed a need for a method of "micro-support." Micro-support refers to a system that operates on a much tighter grid of response than the existing more large-scale systems. Imagine a body lying on his/her side on a conventional mattress. The arc formed by the depression of the shoulders into the mattress might have a radius of 3 to 4 inches, thus preventing it from providing support within the depressed area. If the radius could be reduced to, say, .25 or .5 inches, the mattress could conceivably offer functionally continuous support.

[0009] In response to this oversight of available designs or solutions, an aspect of the present invention is a micro-support platform with a plurality of independent

shock absorbers. The present invention relates to a structure for providing support on a smaller scale as mentioned above so that a portion of the human body being supported is essentially provided with what approximates continuous support. In accordance with the present invention a device comprised of (1) a cylinder, (2) a rod, and (3) a compression spring that when aligned side by side in groups can respond almost infinitely to varying loads across a given X Y dimension and thereby provide more continuous support to a portion of a human body.

[0010] This system can be used for mattresses, furniture, car seats, or indeed for any support system used by most anyone in almost any situation. One such application is for the inner sole of any shoe: dress, casual, sports, work, or medical.

[0011] Additional aspects and advantages of this invention will be apparent from the following detailed description of preferred embodiments, which proceeds with reference to the accompanying drawings.

Brief Description of the Drawings

[0012] Fig. 1A is a side sectional view of a layered spring structure for use with a micro-support cushion support system in accordance with the present invention.

[0013] Fig. 1B is a top plan view of the layered spring structure of Fig 1A.

[0014] Fig. 2 is an exploded side perspective view of a shoe inner sole incorporating an embodiment of the micro-support cushion system of the present invention.

[0015] Fig. 3 is an exploded top perspective view of the shoe inner sole of Fig. 2.

[0016] Fig. 4A a side sectional view of a first spring structure of the shoe inner sole of Fig. 2.

[0017] Fig. 4B is a side sectional view of a second spring structure of the shoe inner sole of Fig. 2.

[0018] Fig. 4C is a side sectional view of a third spring structure of the shoe inner sole of Fig. 2.

Detailed Description of Preferred Embodiments

[0019] In accordance with the present invention, by placing small "shock absorbers", such as the springs shown in Figs. 1A, 1B, and 4A-4C, at .250" intervals (that's 16 to a square inch) forms a tight responsive grid system. As a foot supported by the inner sole shown in Figs. 2 and 3 plants and then rotates with momentum created by walking, the tight grid system absorbs the energy with almost continuous support throughout the stepping cycle.

[0020] One example of such shock absorbers are an array of guides, rods, and compression springs. These various components are one technique of manufacture; there are many benefits available to this design as custom designs can be offered to support the diversity of human anatomical needs.

[0021] A single layer of thermoplastic exhibits only one characteristic curve of deflection. Metal springs, on the other hand, can be designed to exhibit different compressions ratios from coil to coil. In practice, this allows a spring to handle varying loads that could represent the different forces attributable to standing, walking, running, or jumping. Conversely, a thermoplastic has a fixed rate of compression as it is compacted to its solid height. In practice, a specific durometer is selected for the thermoplastic, restricting its response rate to a linear curve rather than to a variable characteristic curve as is present in traditional springs.

[0022] An aspect of the present invention includes a design that can mimic the characteristics of a compression spring from a single thermoplastic, thus taking advantage of the cost benefits associated with injection molding. The design is shown as the layered spring structure of Figs. 1A and 1B.

[0023] With reference to Figs. 1A and 1B, the force needed to compress a smaller top layer of the layered spring structure is a function of the top layer's surface area multiplied by its deflection rate. Once the top layer is compressed, any additional force acts to compress the a larger second layer. The compression rate of the second layer is greater than that of the first layer to the degree that the second layer has a larger surface area than the top layer. The corresponding change in compression rate is experienced throughout each layer of the layered spring structure and is similar to the behavior exhibited by a compression spring even though the layered spring structure is formed from a single plastic.

[0024] Furthermore, more predictable changes in the deflection rate can be produced if instead of a flat surface compressing the layered spring, as shown in Fig. 4C , a layered compression structure as shown in Fig. 1A is used. The layered compression structure of Fig. 1A is similar in dimension and shape to the layered spring structure shown in Fig 1 A, except that the height of each inverted layer of the layered compression structure is less than the height of a corresponding layer in the layered spring structure, or in other words the layered compression structured appears recessed relative to the layered spring structure. Accordingly as the layered compression structure is compressing the top layer of the layered spring structure

the layered compression structure begins to compress the second layer of the layered spring structure before the first layer of the layered spring structure is fully compressed. This process continues for each layer of the layered spring structure until it is fully compressed. In this manner more predictable changes in the deflection rate can be engineered while at the same time using this device to add lateral support to each layer.

[0025] Further improving the effect of a variable deflection rate, and thus replicating the effect of a compression spring, accomplished by constructing the above described layered compression structure from a thermoplastic that had its own deflection properties albeit selected at different durometers than the thermoplastic used for the layered spring structure.

[0026] An array of the layered spring structures on a carrier sheet can be used to form the bottom of the shoe inner sole of Figs. 2 and 3. An array of the compression structures on a carrier sheet can be used to form the tope of the shoe inner sole of Figs. 2 and 3. The compression devices sits on top of the layered spring structures and is the part of the shoe inner sole that contacts the foot. In this manner an inner sole can be constructed that has different compressions rates that are triggered by forces expected from standing, walking, running, jumping, etc. By selecting a material with elastic properties for the top component array, and by varying the thickness of the carrier sheet between each compression unit, each layered spring structure can move independent of the other layered spring structures in the array. This allows the durometer of the basic thermoplastic to be selected for one condition, e.g., standing, and geometrically altering its compression ratio by varying the surface area of contact with the upper compression device, e.g., increasing the points of contacts and therefore surface area to handle the greater forces expected from more aggressive activities.

[0027] Moreover and once in use, as the upper unit is compressed into the lower unit, the action is like a bellows creating a desirable airflow. The direction of the airflow can be directed to cool the foot or simply keep it dry.

[0028] Using this layered spring structure as described above provides many of the benefits of a compression spring array, with the cost and construction benefits of an injection molded structure.

[0029] Once a production material has been selected a force/compression curve for the shoe inner sole can be calculated. The relevant human motions or activities

that are typically involved are standing, walking, running, and other typical bipedal motor skills. The forces exerted by the above mentioned activities generally fall into clusters rather than a linear curve. The layered spring structure as described above is well suited to accommodate sudden and large increases in force such as might be expected when a user shifts between walking (which is on the order of 1.0 to 1.5 x body weight) and running (which is on the order of 2.0 to 4.5 x body weight). An X/Y plot of the anticipated performance of the layered spring structure response will be stair-stepped; normally following the total square surface area being compressed (the compression properties of the material being a constant). Although an aspect of the present invention was shown in the drawings as a cylindrical layered spring structure and a cylindrical layered compression structures drawing the invention is not limited to that structure. A design can be formed using frustrum (the truncated base of a cone) shaped layered spring structures and frustrum shaped layered compression structures. A frustrum shaped design benefits from having a greater mass at its base, and the energy dissipation throughout this unreinforced plastic can help reduce flex-fatigue and can help perpetuate the resiliency under intermittent loads.

[0030] It will be obvious to those having skill in the art that many changes may be made to the details of the above-described embodiments without departing from the underlying principles of the invention. The scope of the present invention should, therefore, be determined only by the following claims.